

**MINIATURE, PULSATILE IMPLANTABLE VENTRICULAR ASSIST DEVICES AND
METHODS OF CONTROLLING VENTRICULAR ASSIST DEVICES**

ABSTRACT

[00156] A pumping system for assisting either or both ventricles of the heart. In one embodiment, separate devices are provided for each ventricle. In another embodiment, one device provides both right and left pumping. The pumping system is small, efficient, atraumatic, and fully implantable. In addition, the pumping system can provide pulsatile flow during systole. The ventricular assist device includes an actuator plate between a pair of serially connected pumping chambers that operate in a two-stroke mode, specifically a power stroke and a transfer stroke. The ventricular assist device also includes an electromagnetic drive system that provides adjustment to the pump pressure according to the current through an electromagnet. For the pumping system, springs provide a "spring force" on the actuator plate that is towards the high-pressure pump chamber. The bias force allows the springs to store and deliver energy from the electromagnetic drive system to provide better utilization of the pump components, and to reduce the pump size and consumption of electricity.